

Web51 – I/O Controller lite

Software guide

This application uses the Web51 system to control RS232, 8 inputs, 8 outputs, LCD display and up to 4 thermometers over an Ethernet network using WWW or Telnet.

The application is distributed pre-loaded in a microcontroller and is configurable over the serial line.

Basic description

The described application is supplied free of charge together with the Web51 development kits. Control of any device over a computer network now becomes very simple and does not require any programming. If the application does not exactly fit your needs, you can use the development system (available on the Internet free of charge) to develop your own solution based on the HW design kit.

Remotely controlled peripherals

The IO Controller Lite utilizes the Web51 HW design kit version 3.2 or 3.68 and supports two ways of connecting the outputs, configurable in the SETUP mode over the RS232 serial line.

Direct access to the 8-bit port P1

Use this option if you need only a few outputs. All 8 pins of the P1 port are remotely controlled.

- Access to the RS232 port over TCP/IP from a PC (telnet only)
- Control of an 8-bit I/O port

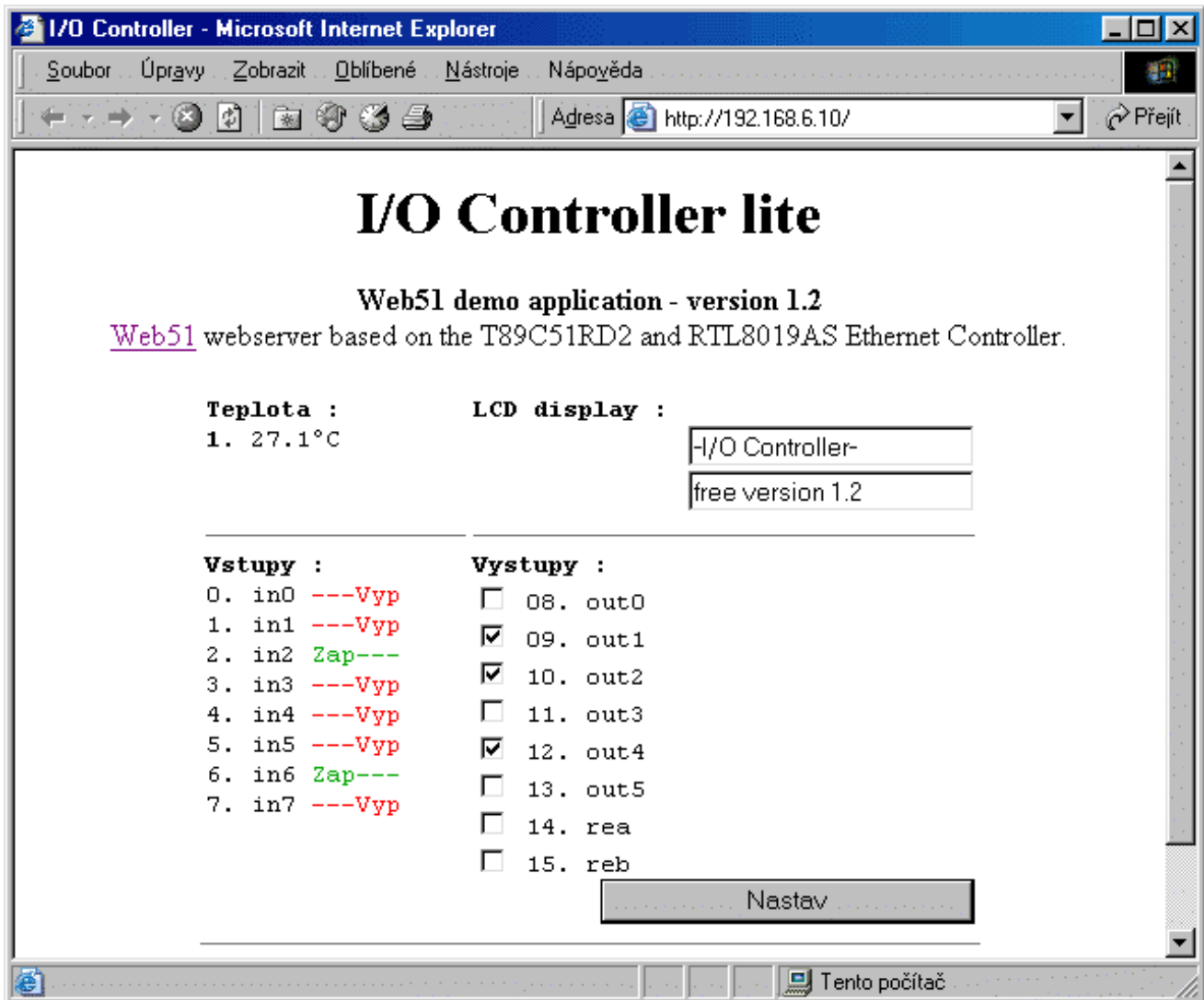
Use of external shift registers

The number of connected peripherals can be significantly extended by connecting external shift registers as specified in our recommended schematic.

- Access to the RS232 port over TCP/IP from a PC (telnet only)
- Control of an 8-bit input port (shift register 74165)
- Control of an 8-bit output port (shift register 74595)
- Detection and reading of at most 8 thermometers DS1833
- Output to a liquid-crystal display (connected to a 74595 shift register)

Controlling the IO Controller Lite through a WWW page:

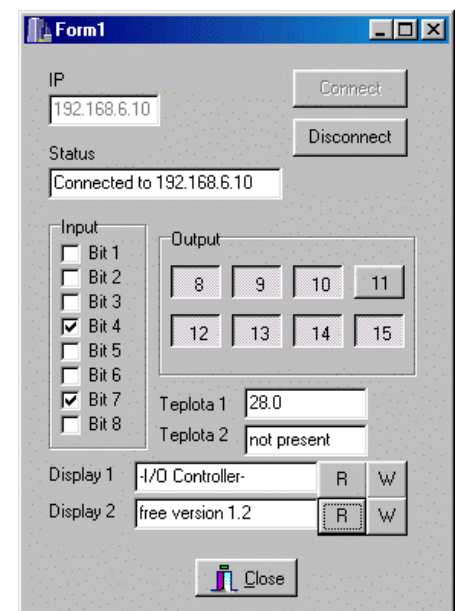
The HTTP interface is ideal for simple control. It is comfortable for users and can easily utilize, for example, PHP scripts. The I/O Controller Lite supports control of all peripherals from a HTML page; an example is shown below.



Controlling the IO Controller Lite from a TELNET application:

Besides the WWW interface described in the previous section, the I/O Controller Lite can be controlled from the command line over a TELNET interface. A simple application in C++ Builder is presented to demonstrate this method. The application displays an interface shown in the picture and connects over an Ethernet network to the specified IP address. Through an external component, the application then opens a "Telnet"-type connection and uses it to control the remote I/O Controller.

The source code of this application is included on the shipped CD and can be simply and quickly adapted to individual needs, allowing the I/O Controller as well as the I/O Controller Lite to be used in fully commercial applications.



Setting up the I/O Controller Lite over RS232 (SETUP)

First start

After programming the microcontroller in a parallel programmer, the web51 needs to be switched to the SETUP mode (see below) and “reset to defaults” (press “d” and answer “y” to the “are you sure?” prompt). This starts the initialization of the internal EEPROM memory. At least the IP address (“i”) and netmask (“m”) must be specified. After a restart (“r”), the Controller is ready to operate. If the initialization is not performed, the internal EEPROM is in undefined state!

SETUP Mode

To invoke the SETUP mode, press and hold (about 3 seconds) the button controlling pin P3.4 – T0 immediately after microcontroller reset (the left S1 button in HW version 3.2 or the left JP11 in HW version 3.68).

RS232 settings when in the SETUP mode: 9600Bd,8,N,1 no flow control

In the SETUP mode, the entire device is configured over the serial line. It is necessary to set the IP address, netmask and in some cases the gateway address before starting the network operation for the first time.

If you use DHCP (dynamic assignment of IP addresses), we recommend to give the Controller an IP address that is disabled on the DHCP server.

Access control is not possible with the I/O Controller Lite; see the description of differences between the full and lite versions.

S: Speed

Transmission speed for communication over the serial line in the “Serial Converter” mode (connection to port 23 accesses the serial interface) – 38400, 19200, 9600, 4800, 2400, 1200, 600 [Bd]

==== One-Wire Setup ====

A: Add device (max.4) now: 0

E: Erase all devices

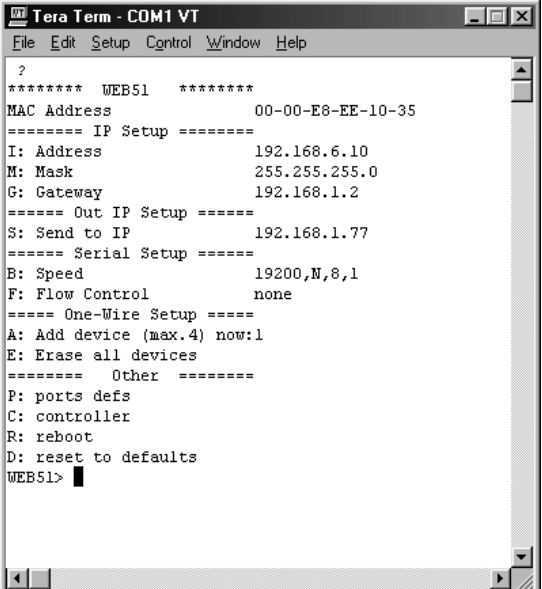
The I/O Controller supports direct measurement of temperature using thermometers connected to the 1Wire bus – e.g. DS1822. The main menu contains an option to search for thermometers connected to the 1Wire bus. The Controller supports reading of temperature from up to 4 thermometers connected in parallel. However, in the search mode, only one thermometer can be connected to the 1Wire bus.

- Option „Add device“ stores the code of the connected DS1822 sensor to the web51 memory.

- Option „Erase all devices“ removes the codes of all thermometers from the web51 memory.

C: Controller

Starts the remote peripheral access interface over the serial line, allowing you to debug connection of peripherals and the communication protocol without using the Ethernet yet.



```

Tera Term - COM1 VT
File Edit Setup Control Window Help
?
***** WEB51 *****
MAC Address          00-00-E8-EE-10-35
===== IP Setup =====
I: Address           192.168.6.10
M: Mask              255.255.255.0
G: Gateway           192.168.1.2
===== Out IP Setup =====
S: Send to IP        192.168.1.77
===== Serial Setup =====
B: Speed             19200,N,8,1
F: Flow Control      none
===== One-Wire Setup =====
A: Add device (max.4) now:1
E: Erase all devices
===== Other =====
P: ports defs
C: controller
R: reboot
D: reset to defaults
WEB51>

```

P: ports defs

Sets up the input and output ports of the I/O Controller and their types. This option invokes a submenu described below.

R: reboot

Restarts the entire system, similar to interrupting the power supply or pressing the reset button.

D: reset to defaults

Cancels any settings and restores default values of everything. Must be used when the application is powered on for the first time after flashing the .hex file into the microcontroller. However, if you have received the application pre-loaded in the microcontroller, everything has been already set up; this option will erase your assigned MAC address.

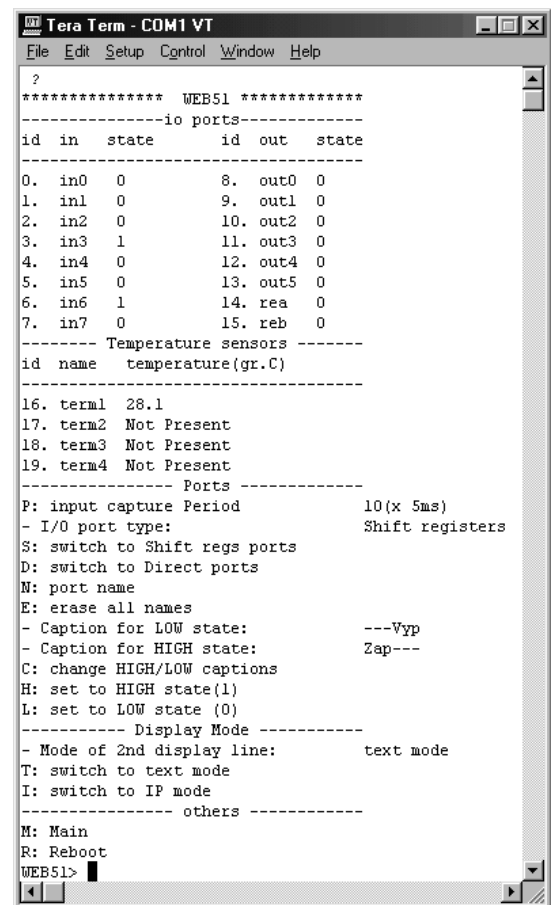
Setting port types in the SETUP mode

The submenu invoked by the “P: ports defs” option is quite long, as shown in the picture. You may need to enlarge the window of your terminal program. We recommend the TeraTerm terminal which is included on our CD with the links.

```
***** WEB51 *****
-----io ports-----
id in state id out state
-----
```

Table lists the I/O ports. Left column contains inputs, right column outputs. Every port is assigned a fixed id and a selectable name (max. 5 chars). The “state” column indicates current state of the port.

```
----- Temperature sensors -----
id name temperature(gr.C)
-----
16. term1 25.4
17. term2 no response
18. term3 Not Present
19. term4 Not Present
```



Current readings of the DS1822 thermometers. Every thermometer is assigned a fixed ID and a selectable name (max. 5 chars). The “temperature” column indicates current temperature, or “no response” if the sensor does not communicate for any reason. If the given sensor is not installed, a “Not Present” message is displayed.

P: input capture Period 99(x 5ms)

Specifies how often are the inputs read (in multiples of 5ms) and any changes reported to the master system. An artificial delay can be used in certain applications for example to accommodate for a slow response of a controlled technology process.

Outputs are set as soon as the corresponding value is received over the Ethernet.

- I/O port type: **Shift registers**
S: switch to Shift regs ports
D: switch to Direct ports

Defines how the I/O Controller Lite should access external peripherals.

“**S: switch to Shift regs ports**” – External shift registers are assumed to be connected to port P1, extending the number of peripherals to 8 inputs, 8 outputs, a LCD display and 4 1Wire thermometers.

“**D: switch to Direct ports**” – Port P1 is directly accessible; however, only 8 I/O pins and no other peripherals can be controlled remotely. Ideal for simple applications and debugging. No LCD support; the Controller will ignore any display operations.

N: port name

This option allows naming and renaming of signals.

E: erase all names

Clears all names of ports with id's 0 to 15 that were assigned to individual input and output pins.

- Caption for LOW state: **---Vyp**
 - Caption for HIGH state: **Zap---**
C: change HIGH/LOW captions

If the WWW interface will be administered by a non-technical person, custom names of inputs and states are a good way of informing the user about errors indicated by a remote input (for example, L – OK, H – ERROR).

H: set to HIGH state(1)

L: set to LOW state (0)

These two options allow changing the state of a binary output directly in the SETUP mode (useful for debugging purposes).

----- Display Mode -----
 - Mode of 2nd display line: **text mode**
T: switch to text mode
I: switch to IP mode

If the display is active (inputs/outputs are in the “Shift Registers” mode), the „Mode of 2nd display line“ specifies whether the second LCD line will display an user-specified text (Text mode) or the IP address of the other party to the last established TCP connection (IP mode).

Using the I/O Controller functions

Serial Converter – TCP port 23

After a TCP connection to the I/O Controller is established (e.g. with a Telnet utility), the device will pass data received on port 23 over the Ethernet to the serial line output and vice versa. If the I/O Controller does not send or receive any characters during 50 seconds, the TCP connection is automatically closed.

The communication parameters of the serial line are specified in the SETUP mode (default setting is 9600,8,N,1 no flow control).

Limitations of the serial converter

- Only a PC or other system can open the network connection. Lite version of the I/O Controller is not capable of establishing a connection on its own upon reception of data from the serial line. However, it stores up to 512 B of such data in the input buffer.
- Only one “Telnet” connection is supported (no simultaneous connections). Therefore, it is not possible to access the serial line at port 23 and at the same time control the inputs and outputs at port 26. The HTTP server is independent and can operate simultaneously with any of the two “telnet” connections.
- This implementation of the Serial Converter is not comparable to our “Ethernet – Serial converter” application, which is capable of defining the transfer protocol, remote configuration of the serial port as well as the entire device according to RFC, UDP data transfer, active mode, and more.

I/O Controller Lite – TCP port 26

All inputs, outputs and Controller-managed peripheral devices (LCD, thermometers, etc.) have a fixed ID. Each ID can have a 5-byte alias consisting of letters and numbers. For instance, the first thermometer with ID 16 has a default alias “term1”. These IDs serve for unambiguous addressing of the remotely controlled devices.

Aliases can be changed in the SETUP mode. When the Controller is in operation, they can be used but not changed.

Aliases can be used in Controller commands; however, such commands are prefixed by the “\$” character, while ID addressing uses the “#” prefix.

ID	Std.Alias	Description
0	In1	binary input 1
1	In2	binary input 2
2	In3	binary input 3
3	In4	binary input 4
4	In5	binary input 5
5	In6	binary input 6
6	In7	binary input 7
7	In8	binary input 8
8	out1	binary output 1
9	out2	binary output 2
10	out3	binary output 3
11	out4	binary output 4
12	out5	binary output 5
13	out6	binary output 6
14	rea	binary output 7
15	reb	binary output 8
16	term1	temperature sensor DS1622 1
17	term2	temperature sensor DS1622 2
18	term3	temperature sensor DS1622 3
19	term4	temperature sensor DS1622 4
24	disp1	alphanumeric display 2x16chrs. – 1 st line
25	disp2	alphanumeric display 2x16chrs. – 2 nd line

General syntax of Controller commands.

The following syntax is used for remote control: `port.command <enter>`

port specifies the device to be controlled. Device ID can be specified in two ways:

- **#<ID>** for example “**#16**” for the 1st thermometer
 - **\$<alias>** for example “**\$term2**” for the 2nd thermometer
- separates device specification and action command

command specifies the action to be performed with the given ID

- **?** – status inquiry
 - for example “**#16.?**” – prints out the status of the input with ID=16
 - for example “**\$in1.?**” – prints out the status of the 1st binary input with ID=16
- **s<string>** – other, such as text output for LCD
 - for example, “**#24.sHELLO**” prints out “HELLO” on the first line of the display
- **1** – sets a binary output to HIGH (logic 1)
 - for example, “**#8.1**” sets out1 (the first binary output) to HIGH.
- **0** – sets a binary output to LOW (logic 0)
 - for example, “**\$rea.0**” sets ID=14 (7th binary output) to LOW

Example operations with binary inputs/outputs

- status reading:

```
port.?  
port=ID<0,15>
```

Example:

```
$in1.? ->1  
#10.? ->0
```

- set the output to HIGH (1) or LOW (0):

```
port.<1,0>  
port=ID<8,15>
```

Example:

```
$out1.1 <ok>  
#15.0 <ok>
```

Operations with DS1822 thermometers

- status reading:

```
port.?  
port=ID<16,19>
```

Example:

```
$term1.? ->25.4
```

Possible error messages:

```
"-> not present" ... sensor is not installed  
"-> no response" ... sensor does not react
```

Operations with alphanumeric display, 2x16 chars

- read contents of the display buffer:

```
port.?<enter>  
port=ID<24,25>
```

Example:

```
$disp1.? ->Whatever text
```

- write a new string to the display buffer:

```
port.s<string><enter>  
port=ID<24,25>
```

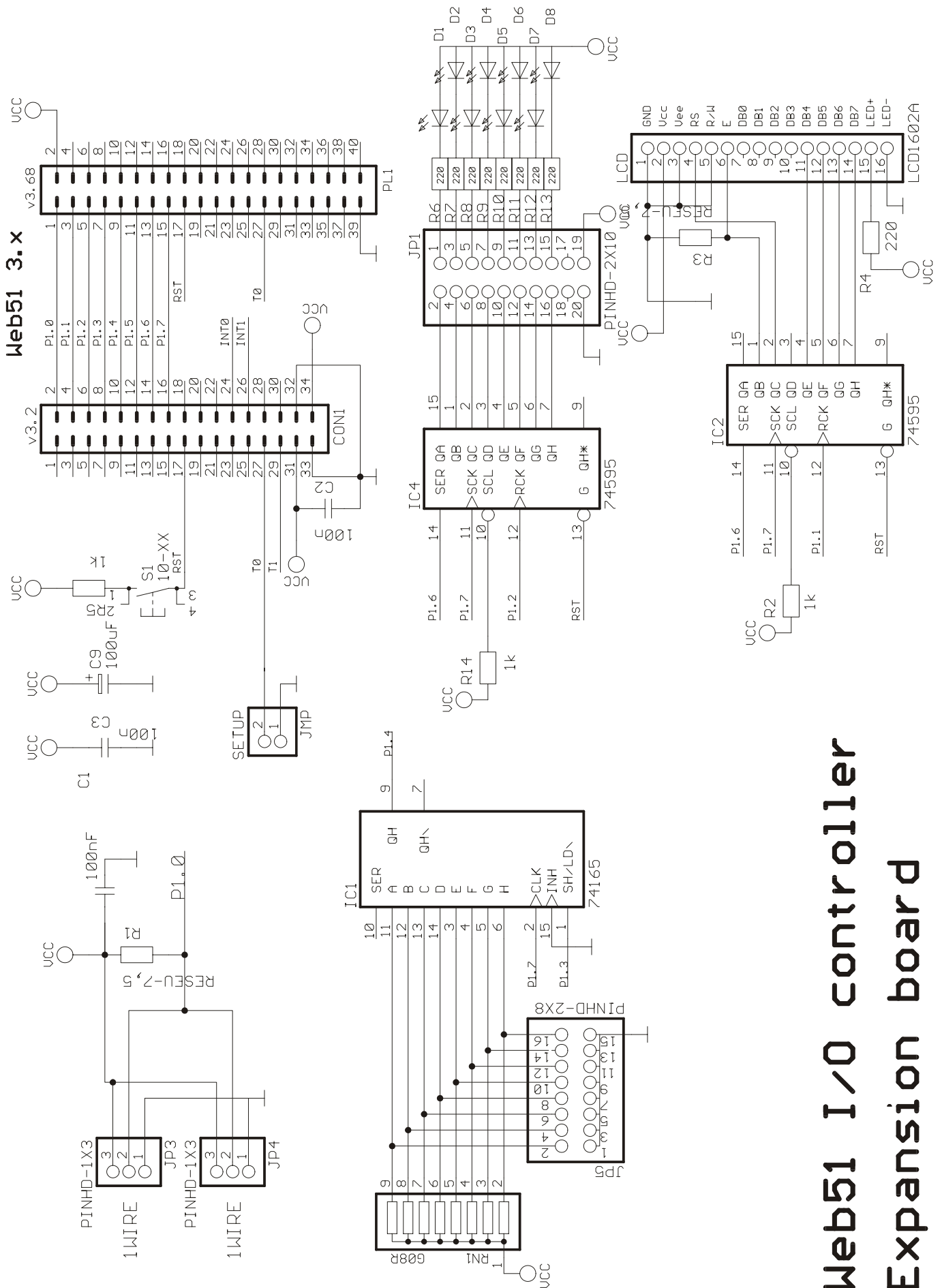
Example:

```
$disp2.sHello World <ok>
```

Note: If the display is set to "IP mode" in the SETUP mode, any attempt to write a new string to the second display line will generate the "*!-Read Only*" message.

Connection of external peripherals

If you choose shift register operation, the following circuit is recommended.



Web51 I/O controller Expansion board

Delivery of I/O Controller Lite

The I/O Controller Lite is a software-only application for the T89C51RD2 microcontroller and is normally shipped with the Web51 HW design kit. It is currently delivered with the "HW design kit" version 3.2 and 3.68 (for datasheets, see the download section).

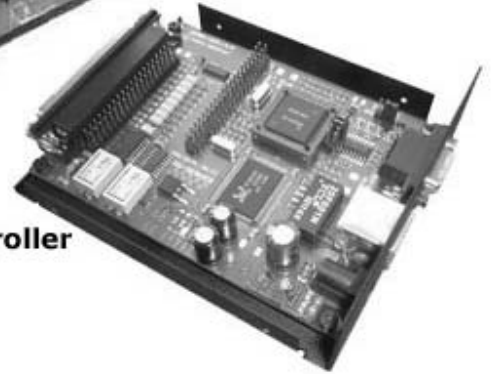
If you want to develop your own application, we recommend to order another RD2 microcontroller with your kit. All microcontrollers are preloaded with our loader (for info, see download), which is compatible with the original one and is also able to program the internal EEPROM.

Application available with this HW :

Web51 ver. 3.68 - HW design kit

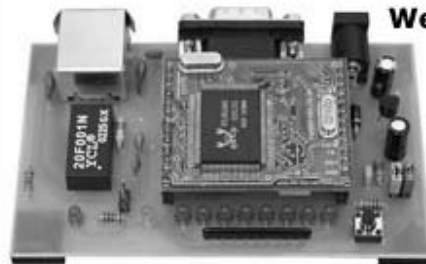


Web51 ver. 4.5 Industrial Controller



Web51 ver. 6 - Charon

Ethernet module + MotherBoard PCB



Now this application is newly also available for:

- **HW version 6.x** (small 4x3cm 10-pin module with an external RJ45 connector and a transformer, intended for soldering into your own PCB) (*10Mbit hardware costs about \$80*)
- **HW vesion 7.x** (a small module with an external RJ45 connector and a transformer, pin-compatible with the Rabbit RCM2200, intended for soldering into your own PCB and mapping into the application address space) This module will support programs in KEIL C. (*10Mbit hardware costs about \$80*)

Source code of this application is included in the full version of the development system, which is a part of the DEVELOPER 2 package. Compiled .HEX file is included on the Ethernet CD together with the Web51 utilities.

Differences between FULL and LITE version of the I/O Controller

Lite version of the I/O Controller is a released demo of our I/O Controller. It is implemented free of charge on the existing Web51 design kit hardware to demonstrate the possible range of applications.

The full version of the I/O Controller ships with the industrial hardware version 4.x. In many applications it can substitute Ethernet-enabled PLCs for a substantially lower price.

Features of the I/O Controller (full version):

- Sends e-mails upon defined events.
- Supports up to 8 actions triggered by temperature, input values, or network inactivity. Actions can modify all network outputs of the I/O Controller (sending e-mails, reporting changes to a master system over HTTP or TELNET) or directly control the output pins of the I/O Controller.
- Supports “smart network watchdog” functions that can react independently or to network commands.
- Can limit access to certain IP addresses via the address and netmask, deny remote access from individual sources, encryption with the TEA algorithm. (Lite version does not provide any access control or encryption.)

Full I/O Controller with industrial version of HW costs approx. \$200.
– for more info, e-mail prodej@HW.cz

Links and Download

- Product WWW pages - http://www.hw.cz/products/io_controller/io_controller_lite.html
- HW Design kit datasheets – version 3.2 and 3.68
- Web51 project server - <http://Web51.HW-server.com>
- You can find the file **IO_Controller_lite.hex** on the Ethernet CD or on the Web51 CD.

Contact information

- Updates and technical information – <http://www.HW.cz>
- Order in the on-line store <http://Shop.HW.cz>.
- For technical information e-mail Aplikace@HW.cz or call+420-222-511-918
- Prices of the standalone HW design kits start at **\$100**.
The described I/O Controller Lite is included.
Please order at **<http://Shop.HW.cz> -> Web51 -> Web51 HW KIT**